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EXPERIMENTS
AND
OBSERVATIONS
ON
A NEW APPARATUS,
CALLED,
A MACHINE for exhibiting perpetual ELECTRICITY.

IN A LETTER TO
The Rev. Dr. HORSLEY, Sec. R. S.
FROM
Mr. WILLIAM HENLY, F. R. S.

Read at the ROYAL SOCIETY, May 16, 1776.

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BRITISH MUSEUM
30 AUG 61

EXPERIMENTS, &c.

TO THE REV. DR. HORSLEY.

REVEREND SIR, March 4, 1776.

MY ingenious friend Mr. GEORGE ADAMS, philoſophical inſtrument-maker to his majeſty, lately put into my hands a little apparatus, which he called a machine for exhibiting perpetual electricity, and informed me, that it was the invention of ſome foreign gentleman(a). This machine conſiſted of a circular plate of glaſs, about eight inches in diameter, covered on one ſide with a coating of bees-wax and roſin, about the ſixteenth part of an inch thick. This coat of wax, &c. being ſtrongly excited with a dry warm flannel, he placed upon it a circular board, of the ſame dimenſions, coated with tin-foil, and furniſhed with a glaſs handle ſcrewed to, and ſtanding upright upon it. Theſe bodies having remained in contact ſome ſeconds, the board was raiſed up by the glaſs handle; when, applying the knuckle to the tin-foil coating, a ſnap was heard, a ſpark ſeen, and a ſmall ſenſation felt. On replacing the board, and permitting it to remain ſome ſeconds, as before, having touched the tin-foil with a finger, on removing it again, and applying the knuckle, as at firſt, the ſame phenomena were produced; and might, Mr. ADAMS obſerved, be repeated for a long time, without any renewal of the excitation of the wax, any farther than the replacing the board might be ſaid to excite it. It immediately occurred to me, that, as this plate of wax, &c. was made by excitation, a ſtrong negative electric, the phenomena produced by it could only be the reverſe of thoſe I had formerly made with an excited plate of glaſs, and publiſhed in the Phil. Tranſ. vol. LXIV. part II. p. 407.; *viz.* where mine were poſitive, theſe were negative; and where mine were negative, theſe were poſitive. But, to determine this matter, I made the following experiments. Firſt, I inſulated Mr. CANTON's electrometer, and having electrified the balls poſitively, I preſented toward them the excited wax, as ſoon as it had been ſeparated from the coated board; and perceived, as I expected, that the balls were attracted by the wax; but, if the balls were electrified negatively, they were as plainly repelled by it. The board produced juſt the contrary effect. Secondly, I held my Leyden *vacuum*, or analyſis of the Leyden bottle, deſcribed Phil. Tranſ. vol. LXIV. part II. p. 400. by the coated bulb, and touched the braſs ball on the neck of it with the coated board, the moment it had been ſeparated from the excited wax, &c. and inſtantly perceived a variety of beautiful ſtreams dart from the point of the wire in the bottle, and ſpread themſelves in different directions through the bulb. On repeating the experiment, and preſenting the coated part of the bottle toward the board, a ſmall ſpark of light appeared upon the point of the incloſed wire; a plain

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(a) I have ſince learned from Mr. NAIRNE, that M. VOLTA, of Coma, near Milan, was the inventor of it.

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BRITISH MUSEUM 30 AUG 61

indication that the point had received electricity, and, as before obſerved, that the coated board, being ſeparated from the wax, &c. was ſtrongly electrified *plus*; and conſequently, the coating of wax, &c. on the plate of glaſs, *minus*. Theſe phenomena, being ſo often produced, without a freſh excitation of the wax, though they are aſtoniſhing to ſtrangers, will not be ſo ſurprizing to electricians, who have conſidered Mr. GREY's experiment with a cone of ſulphur, contained in a glaſs veſſel, which, as often as they were ſeparated, ſhewed ſigns of electricity in all ſtates of the weather. See Dr. PRIESTLEY's Hiſtory of Electricity, 2d edit. p. 39. I have ſhewn at large, in a former paper, that merely heating either glaſs or amber will not make them electrical; but the friction of glaſs againſt glaſs, or ſealing-wax againſt ſealing-wax, previouſly warmed, I find, will excite either of theſe ſubſtances; and my ingenious and learned friend THOMAS RONAYNE, Eſq. informs me, that he had long ſince made the ſame remark on ſealing-wax. But, preſſing a finger in the gentleſt manner on the amber, after heating, will excite it. Indeed, a fine piece, which I frequently carry in my pocket, I always perceive to be electrical, without any other friction than what it receives from the pocket. Sealing-wax, Mr. RONAYNE tells me, he always found to be affected in the ſame manner; and negative electrics, *per ſe*, being once thoroughly excited, are obſerved to retain their electrical quality very long, as they do not ſo ſoon attract the moiſture in the atmoſphere as glaſs. Glaſs, however, will retain its electricity many hours, as I have had frequent occaſion to remark. My late friend

Mr. CANTON informed me, that, having excited a rod of glaſs very ſtrongly, he ſet it at ſome diſtance from the fire in his parlour, and found that it was electrical, after ſtanding in that ſituation, in dry air, twenty-four hours. How much longer it would have retained its electricity, had he let it remain there, he knew not. How long a large and neatly-prepared Leyden bottle will retain its charge, ſo as to be ſenſibly electrical, I have never experienced; but Dr. PRIESTLEY obſerves, Hiſtory of Electricity, p. 516, that he has more than once received ſuch ſhocks as he ſhould not like to receive again from the *reſiduum* of his battery, even two days after the diſcharge, and when papers, books, his hat, and many other things, had lain upon the wires the greateſt part of the time. Even the *reſiduum* of a *reſiduum*, he ſays, he has known to remain in his battery many days(a). One thing, however, is very remarkable in Mr. ADAMS's apparatus, *viz.* ſuppoſing the negative electric to have parted with its electricity to the rubber; why, when the coated board or plate of metal is ſet upon it, and that plate is touched by a finger, the equilibrium is not thus preſently reſtored? But, perhaps, when the electric matter, naturally inherent in bodies, is once thoroughly excited and put in

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(a) My friend the reverend Mr. HEMMING, hath been ſo obliging as, at my requeſt, to make a variety of experiments, with a view to determine this matter, and ſhewed me a ſmall bottle, which attracted a thread of trial at one-ſixteenth of an inch diſtance, May 23, though the bottle had been charged and ſtood in a cupboard in his ſtudy from March 14, *viz.* 70 days. The cylinder to his electrical machine will alſo ſeparate the balls of Mr. CANTON's electrometer a fortnight after uſing, though a variety of methods have been repeatedly uſed to deſtroy that power in the interval.

action,

action, it is not ſo ſoon as might be ſuſpected reduced again to a quieſcent ſtate, eſpecially in bodies ſo peculiarly adapted to affect each other as theſe appear to be. Mr. LANE has favoured me with a very curious experiment, which he made as long ſince as the month of June 1764, and then ſhewed to many of his friends, which ſeems fully to confirm this opinion. I have, therefore, requeſted his leave to inſert it, as follows. Having procured two large pieces of thick plate glaſs A and B, with plain ſurfaces, and fitted them ſo as to coincide with each other, he coated a part (about eighteen ſquare inches) of A, on one ſide, with tin-foil, and an equal part of B he coated in the ſame manner, ſo as to anſwer exactly to A, leaving a margin of glaſs, an inch and a half broad, in the narroweſt part; but, at one of the ends of each plate (which end was reduced in breadth), not leſs than five inches of the glaſs were reſerved uncoated, for the purpoſe of handling them. The uncoated ſides of theſe glaſſes being laid together, they were charged by the machine as one plate; when the plate A, which touched the prime conductor, was found, on ſeparating them, to be poſitive on both ſides; and B, which was touched by a finger during the operation, was negative on both ſides. Then, laying them in contact, as at firſt, and making the diſcharge as with the Leyden bottle, the plates were ſtill found to cohere, and after ſeparation were obſerved to remain ſtrongly electrical; but with an electricity directly contrary to that they ſhewed before the diſcharge, A being now negative, and B poſitive on both ſides. But, what is particularly to my purpoſe, if the coating on A and B (after laying them again together as at firſt) were touched, at the ſame time, by a thumb and finger of the hand, or any conductor communicating with the earth, the plates would then, on being ſeparated (the experiment being made in a dark room) emit a ſtrong flaſh of light; and this phenomenon Mr. LANE has frequently produced twelve or fourteen times ſucceſſively, touching the coating of the plates each time before the ſeparation, without renewing the charge in the glaſs by the machine; but if he omitted to touch the coatings as above mentioned, no light was viſible on the ſeparation of the plates (*b*). Should thoſe gentlemen, if any ſuch remain, who are of opinion, that in electrical experiments two fluids, the vitreous and the reſinous, are concerned, proceed to make experiments of this kind, they may, perhaps, from ſome phenomena, be induced to draw concluſions which they may think not unfavourable to their own hypotheſis.

My experiments with the excited plate of glaſs, publiſhed in the Philoſophical Tranſactions, as before mentioned, may ſerve, however, as a key to explain both Mr.

(*b*) Crown-glaſs, that is, the glaſs commonly uſed for ſaſh-windows, though ſo much thinner, ſucceeds in this experiment as well as the plate-glaſs; but what is very remarkable, the Dutch plates, when treated in the ſame manner, have each a poſitive and a negative ſurface, and the electricity of both ſurfaces, of both plates, is exchanged for the contrary electricity in the diſcharge. If a clean, dry, uncoated plate of looking-glaſs be placed between the coated looking-glaſs plates, or between the plates of crown-glaſs, it appears, after charging, to be negatively electrified on both ſides; but if it be placed between the Dutch plates, it acquires, like them, a poſitive electricity on one ſurface, and a negative electricity on the other. Further particulars, with a deſcription of ſome new electrical apparatus, conſtructed on account of theſe phenomena, will be given at another opportunity.

GREY's experiments, and thoſe made with Mr. ADAMS's little apparatus now under conſideration. Having procured a plate of glaſs, ten inches long and eight inches broad, coated in the manner of Mr. ADAMS's, I was inclined to purſue theſe inquiries ſomewhat farther. Accordingly, I placed, upon a ſtrong ſupporter of glaſs, a circular board, with a ſmooth and flat ſurface; and upon this board I laid a circular braſs plate, of nearly the ſame ſize; and laſtly, I placed upon the braſs plate Mr. CANTON's electrometer. Then, having excited the plate of wax with dry, warm flannel, experiment 3, I ſet it upon the inſulated apparatus. The balls preſently opened, and, on examination, appeared to be electrified negatively; but, on removing the wax, they cloſed, and opened again much wider, and were then found to be electrified poſitively. In this experiment, the quantity of electricity, naturally inherent in the balls, ſtrings, &c. had been drawn up into the apparatus by the attractive power of the excited plate of wax, and they were thus left in a negative ſtate; but, on removing the plate of wax, the balls cloſed again, in conſequence of the return of the electricity, which would be increaſed if the plate of braſs had been touched by a finger, &c. and the balls then became very powerfully electrified *plus*. By applying, in the ſame manner, the excited uncoated plate of glaſs, or the excited uncoated ſide of the ſame plate, the reverſe of theſe phenomena took place, as I have before deſcribed them and referred to in the beginning of this paper.

Experiment 4. I inſulated two of Mr. CANTON's electrometers, A and B, and having raiſed them in ſuch a manner

manner as to let the balls hang about the eighth part of an inch higher than the plate of braſs on which the excited plate of wax was laid, I electrified the balls of A poſitively, and the balls of B negatively, ſo as to diverge about an inch; I then brought the inſulated apparatus as near as I could to the balls, without affecting either, (the braſs plate might then be at nearly an inch and an half diſtance from the neareſt ball, both of A and B); then, ſuddenly removing the excited wax, the balls of B inſtantly flew to the braſs plate, and thoſe of A were, at the ſame inſtant, repelled to as great a diſtance from it. The apparatus having remained in this ſituation ſome ſeconds, on withdrawing the ſtand with the braſs plate, &c. the balls of B cloſed, having received by this proceſs the quantity of electricity they had before been deprived of; but the balls of A ſtill remained ſeparate, as wide as ever.

Experiment 5. Having replaced the excited wax, &c. upon the braſs plate, I again electrified the balls of A and B, as in the former experiment, *viz.* thoſe of A poſitively, and thoſe of B negatively. I then took a ſmall phial, properly prepared for the Leyden experiment, containing only about three ſquare inches of coated ſurface; then, preſenting the knob, on the wire of the phial, to the plate of braſs, I removed the wax, &c. and inſtantly ſaw a ſtrong ſpark between the braſs plate and the knob of the phial: when, preſenting that knob towards the balls of A, they were conſiderably repelled; but on preſenting it toward thoſe of B, they were as much attracted. I have made ſeveral other experiments with this apparatus; but, as they all agree with thoſe

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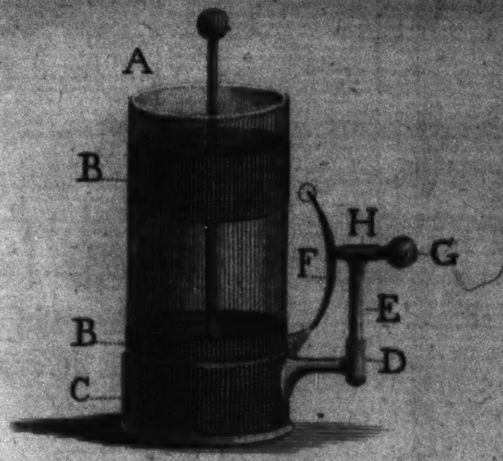

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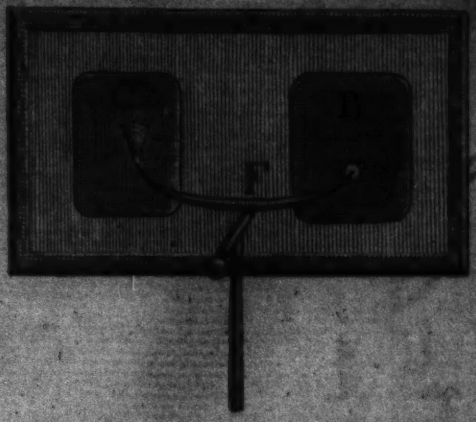

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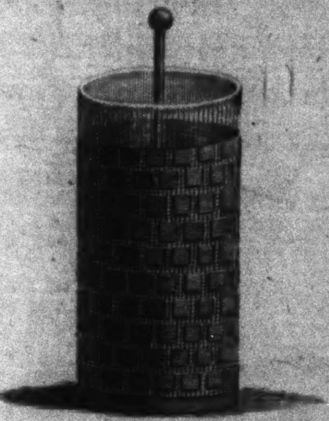

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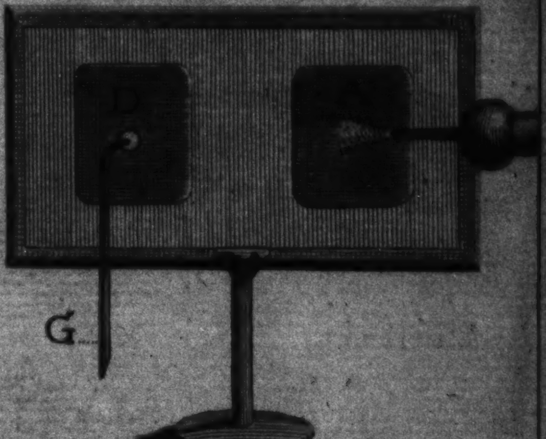

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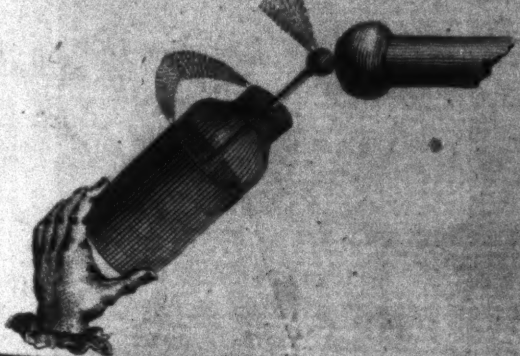

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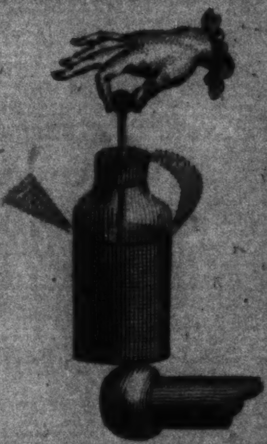

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BRITISH MUSEUM 30 AUG 61

above mentioned, I think it unneceſſary to recite them. I have likewiſe omitted to give a drawing; as to electricians, I apprehend, this paper will be intelligible without one; and to thoſe who have not conſidered the ſubject, I imagine, it would be of very little, if indeed of any uſe whatever. The ſame difficulty which occurred to Dr. FRANKLIN, in his analyſis of the Leyden bottle, may be ſaid to occur alſo in this apparatus, *viz.* it is hard to ſay how, or where this electricity is depoſited, there is ſo much of it; and it is ſo eaſily put in action, that I am ſtill further confirmed in an opinion that I have long entertained, *viz.* that the ſlighteſt friction between bodies of every kind, in every ſituation, may diſturb the electric matter contained in them, though this effect be imperceptible to us, having no electrometer nice enough to diſcover it. I am, &c.

In the month of March laſt, I repeated Mr. GREY's experiment with the cone of ſulphur and the glaſs; and find that, on ſeparating theſe bodies, the ſulphur hath hitherto (c) always acted as a ſtrong negative electric. Mr. WILCKE, in repeating this experiment, obſerved, that if the glaſs veſſel, into which the ſulphur was poured, was covered with a coating of metal, the electrical property of the two bodies would be increaſed, the ſulphur having acquired a ſtronger negative, and the glaſs a ſtrong poſitive electricity (d).

(c) Sept. 23, 1776.

(d) The ſtem of the glaſs ſhould be varniſhed, or covered with cement, and the cone of ſulphur (as M. EPINAS hath directed) be provided with a glaſs handle, that the reſpective bodies may be ſeparated at pleaſure, without touching them.

I have

I have lately ſeen a very neat apparatus, much ſmaller than that I have mentioned in this paper, made by Mr. NAIRNE, the coated plate of glaſs meaſuring only three inches in diameter. With this apparatus I made the following experiments. I inſulated two of Mr. CANTON's electrometers, A and B, and having excited the coating on the glaſs plate, I ſet upon it the plate of metal, and having permitted it to remain in that ſituation about half a minute, I raiſed it up by the glaſs handle, having firſt preſſed it cloſely into contact, and placed it upon the electrometer A. The excited electric I placed in like manner upon B. The balls of both the electrometers diverged conſiderably; thoſe of A poſitively, and thoſe of B negatively. Then, removing the excited plate of wax, &c. from B, the balls cloſed, and opened again poſitively, upon the principle already explained in the preceding paper. If, inſtead of the braſs plate, the plate of glaſs was excited (that is, the uncoated ſide of it), and placed upon the electrometer A, the balls were affected in the very ſame manner (differing only in the degree of power) as thoſe I have before mentioned in my experiments with the excited uncoated plate of glaſs; Phil. Tranſ. vol. LXIV. part II. p. 407.

A variety of new experiments and obſervations, relative to ſeveral articles mentioned in this paper, and other new facts in electricity, particularly the electricity of chocolate, and the reſtoration of that property of it, when loſt, by melting it, with the addition of a ſmall quantity of olive oil, will be preſented to the Royal Society, as ſoon as the materials are properly digeſted and tranſcribed.

30 AUG 61